

AMENDMENTS TO THE CLAIMS

1-3. Cancelled

4. (Currently Amended) An apparatus for formation of a three dimensional object by a sequential deposition of a wire feedstock comprising:

a sealed container capable of maintaining a vacuum environment;

a positioning subsystem contained within said container and capable of controlling the position of said object;

a wire feed subsystem contained within said container and capable of depositing said wire feedstock at a target location relative to said position of said object;

an electron beam subsystem capable of directing energy within said container, ~~and~~ directing energy relative to said position of said object, and melting said wire feedstock at said target location in a sequential manner and sustaining a molten pool at said target location;

a vacuum subsystem capable of creating and sustaining said vacuum environment in said container;

an instrumentation subsystem electronically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, and vacuum subsystem; and

a power distribution subsystem electrically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, vacuum subsystem, and said instrumentation subsystem.

5. (Original) The apparatus of Claim 4, further comprising a substrate attached to said positioning subsystem wherein said sequential deposition of said wire feedstock is initiated on said substrate.
6. (Original) The apparatus of Claim 4, wherein said container is comprised of:
a frame; and
at least one wall attached to said frame.
7. (Original) The apparatus of Claim 6, wherein said frame and at least one wall is formed of a material selected from a group consisting of metal, metal alloy, ceramic, ceramic composite, metal matrix composite, and polymer matrix composite.
8. (Original) The apparatus of Claim 6, wherein said frame and at least one wall is formed of a material selected from the group consisting of titanium, aluminum, aluminum alloys, beryllium alloys and stainless steel.
- 9-10. Cancelled
11. (Original) The apparatus of Claim 6, where said container is further comprised of:
at least one window attached to said at least one wall;
at least one door attached to said frame, to said wall, or both;
at least one electrical feed-through attached to said at least one wall; and
at least one plumbing feed-through attached to said at least one wall.

12. (Original) The apparatus of Claim 11, wherein said window is formed of a transparent material.
13. (Original) The apparatus of Claim 11, wherein said at least one door is formed of a material selected from a group consisting of metal, metal alloy, ceramic, and ceramic composite.
14. (Original) The apparatus of Claim 4, wherein said container has a rectilinear, ellipsoidal, or arbitrary cross-sectional shape.
15. (Currently Amended) The apparatus of Claim 4, wherein said electron beam subsystem is comprised of:
- an electron beam gun capable of directing said energy ~~wherein said electron beam gun incorporates at least one focusing coil and at least one deflection coil;~~
 - an electron beam control element capable of controlling the delivery of said energy from said electron beam gun and electronically connected to said instrumentation subsystem and said electron beam gun; and
 - an electron beam power subsystem electrically connected to said electron beam gun and said electron beam control element and wherein said electron beam power subsystem is capable of supplying power to said electron beam gun and said electron beam control element.
- 16-18. Cancelled

19. (Currently Amended) The apparatus of Claim ~~46~~ 15, wherein said electron beam subsystem is further comprised of:

at least one auxiliary vacuum pump connected to said electron beam gun, electrically connected to said power distribution subsystem, and capable of creating and sustaining a vacuum level within said electron beam gun;

at least one service panel attached to said electron beam gun and electrically connected to said power distribution subsystem; and

at least one user interface screen electronically connected to said electron beam control element and electrically connected to said power distribution subsystem.

20. (Currently Amended) The apparatus of Claim ~~46~~ 15, wherein said electron beam subsystem is further comprised of an electron beam positioning subsystem capable of positioning said electron beam gun relative to said position of said object wherein said electron beam positioning subsystem is electronically connected to said electron beam control element and electrically connected to said power distribution subsystem.

21. (Currently Amended) The apparatus of Claim ~~46~~ 15, wherein said electron beam subsystem is further comprised of an electron beam positioning subsystem capable of positioning said electron beam gun relative to said position of said object wherein said electron beam positioning subsystem is electronically connected to said instrumentation subsystem and electrically connected to said power distribution subsystem.

22. Cancelled

23. (Currently Amended) The apparatus of Claim ~~16~~ 15, wherein said electron beam power subsystem operates is rated from input power in at a voltage range from about 100V to about 240V.

24. (Currently Amended) The apparatus of Claim 23, wherein said electron beam power subsystem operates is rated from input power of at about 110V.

25. (Currently Amended) The apparatus of Claim ~~16~~ 15, wherein said electron beam gun is partially contained inside said container.

26. (Currently Amended) The apparatus of Claim ~~16~~ 15, wherein said electron beam gun power subsystem has is rated to provide an accelerating voltage up to about 60kV.

27. (Currently Amended) The apparatus of Claim 26, wherein said electron beam gun power subsystem has is rated to provide an accelerating voltage up to about 15kV.

28. (Currently Amended) The apparatus of Claim ~~16~~ 15, wherein said electron beam gun power subsystem has is rated to provide a beam power from about 3kW to about 10kW.

29. (Currently Amended) The apparatus of Claim 28, wherein said electron beam ~~gun~~ power subsystem ~~has~~ is rated to provide a beam power from about 3kW to about 5kW.

30. (Original) The apparatus of Claim 4, wherein said positioning subsystem is comprised of:

a moveable platform contained within said container;

at least one positioning subsystem motor capable of moving said moveable platform and electrically connected to said power distribution subsystem; and

a positioning subsystem control element capable of controlling said position of said object, wherein said positioning subsystem control element is electronically connected to said instrumentation subsystem, said moveable platform, and said at least one positioning subsystem motor, and wherein said positioning subsystem control element is electrically connected to said power distribution subsystem.

31. Cancelled

32. (Original) The apparatus of Claim 30, wherein said moveable platform is a four axes moveable platform.

33. (Currently Amended) The apparatus of Claim 32, wherein said ~~four axes moveable platform~~ positioning subsystem control element ~~has~~ is rated to control said four axes moveable

platform within about an accuracy of +/- 0.001 for each linear axis of X, Y, and Z and about 0.01 degrees for the a-axis of rotation in the X-Y plane.

34. (Currently Amended) The apparatus of Claim 32, wherein said ~~four axes moveable platform positioning subsystem control element~~ has is rated to control said four axes moveable platform within a translational speed up to about 250 inches per minute for each linear axis of X, Y, and Z and a rotational speed up to about 20 rotations per minute for the a-axis of rotation in the X-Y plane.

35. (Currently Amended) The apparatus of Claim 34, wherein said ~~four axes moveable platform positioning subsystem control element~~ has is rated to control said four axes moveable platform within a translational speed up to about 50 inches per minute for each linear axis of X, Y, and Z and a rotational speed up to about 10 rotations per minute for the a-axis of rotation in the X-Y plane.

36. (Original) The apparatus of Claim 30, wherein said moveable platform is a five axes moveable platform.

37. (Original) The apparatus of Claim 4, wherein said wire feed subsystem is comprised of:
said wire feedstock;

a wire feed housing contained within said container and capable of accommodating said wire feedstock;

at least one wire feed motor attached to said wire feed housing and electrically connected to said power distribution subsystem;

a wire feeding mechanism attached to said wire feed housing, mechanically connected to said wire feed motor, and wherein said wire feedstock is threaded through said wire feeding mechanism;

at least one wire feed nozzle attached to said wire feed housing and wherein said wire feedstock is fed through said wire feed nozzle; and

a wire feed control element electronically connected to said instrumentation subsystem, said wire feed motor, said wire feeding mechanism, and said at least one wire feed nozzle and electrically connected to said power distribution subsystem.

38. Cancelled

39. (Original) The apparatus of Claim 37, wherein said wire feedstock has an ellipsoidal cross-sectional shape.

40. (Original) The apparatus of Claim 37, wherein said wire feedstock is formed of a material selected from a group consisting of metal and metal alloy.

41-42. Cancelled

43. (Currently Amended) ~~The apparatus of Claim 4, wherein said vacuum subsystem creates and sustains a pressure from about 10^{-4} torr to about 10^{-6} torr in said container.~~

The apparatus of Claim 4, wherein said vacuum subsystem is comprised of:

a plumbing subsystem connected to said container;

at least one pump connected to said plumbing subsystem and capable of creating and sustaining said vacuum environment in said container; and

a vacuum control element electrically connected to said power distribution subsystem, electronically connected to said instrumentation subsystem, and capable of controlling said at least one pump and said plumbing subsystem.

44. (Currently Amended) ~~The apparatus of Claim 4, wherein said vacuum subsystem is comprised of:~~

~~a plumbing subsystem connected to said container;~~

~~at least one pump connected to said plumbing subsystem and capable of creating and sustaining said vacuum environment in said container; and~~

~~a vacuum control element electrically connected to said power distribution subsystem, electronically connected to said instrumentation subsystem, and capable of controlling said at least one pump and said plumbing subsystem.~~

The apparatus of Claim 43, wherein said plumbing subsystem, said at least one pump, and said vacuum control element are capable of creating and sustaining a pressure from about 10^{-4} torr to about 10^{-6} torr in said container.

45-46. Cancelled

47. (Currently Amended) The apparatus of Claim [44] 43, wherein said at least one pump is selected from a group consisting of a turbomolecular pump, a scroll pump, an ion pump, a roughing pump, a cryopump, and a diffusion pump.

48. (Currently Amended) The apparatus of Claim [44] 43, wherein said vacuum control element is comprised of at least one vacuum subsystem sensor electronically connected to said instrumentation subsystem, said at least one pump, and said plumbing subsystem.

49. (Original) The apparatus of Claim 4, wherein said instrumentation subsystem is comprised of:

a means for commanding and controlling data electrically connected to said power distribution subsystem and electronically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, and vacuum subsystem;

a means for measuring processing conditions electronically connected to said means for commanding and controlling data; and

a means for recording data electronically connected to said means for commanding and controlling data.

50. (Currently Amended) The apparatus of Claim 49, wherein said instrumentation subsystem is further comprised of:

a visual monitoring means for monitoring the fabrication process electronically connected to the means for commanding and controlling data; and

a means for monitoring a predetermined set of parameters related to the fabrication process electronically connected to the means for commanding and controlling data; ~~and~~

~~a means for lighting electronically connected to said visual monitoring means for monitoring the fabrication process.~~

51-52. Cancelled

53. (Original) The apparatus of Claim 4, wherein said power distribution subsystem is comprised of:

a means for providing an electrical connection electrically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, vacuum subsystem, and said instrumentation subsystem;

a means for conditioning power electrically connected to said means for providing an electrical connection;

a means for apportioning power electrically connected to said means for providing an electrical connection;

a means for distributing power electrically connected to said means for providing an electrical connection; and

a means for protecting system components from electrical hazards electrically connected to said means for providing an electrical connection.

54. Cancelled

55. (Original) The apparatus of Claim 53, wherein said power distribution subsystem further comprises a means for managing power electrically connected to said means for electrical connection.

56. (Currently Amended) An apparatus for formation of a three dimensional object by a sequential deposition of a wire feedstock comprising:

a sealed container capable of maintaining a vacuum environment;

a positioning subsystem contained within said container and capable of controlling the position of said object;

an electron beam subsystem capable of directing energy within said container and directing energy relative to said position of said object;

a wire feed subsystem contained within said electron beam subsystem and capable of depositing said wire feedstock to a target location relative to said position of said object;

a vacuum subsystem connected to said container and capable of creating and sustaining said vacuum environment in said container;

an instrumentation subsystem electronically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, and vacuum subsystem; and

a power distribution subsystem electrically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, vacuum subsystem, and said instrumentation subsystem,

wherein the electron beam subsystem is capable of melting said wire feedstock at said target location in a sequential manner and sustaining a molten pool at said target location.

57. (Currently Amended) An apparatus for formation of a freeform three dimensional object comprising:

a containment means for enclosing a workspace;

a delivery means contained within said containment means and for depositing a feedstock material in a predetermined pattern and a predetermined rate onto a target;

a positioning means contained within said containment means and for positioning said target to a predetermined location;

an electron beam subsystem capable of directing energy within said container and directing energy relative to said target and melting said feedstock at said target location in a sequential manner and sustaining a molten pool at said target location;

an atmospheric pressure control means connected to said containment means and for creating and maintaining a vacuum environment inside said containment means;

a command, control, and communications means electronically connected to said containment means, electronically connected to said delivery means, electronically connected to said heating means, electronically connected to said positioning means, electronically connected to said atmospheric control means, and for commanding, controlling, and providing communications for said delivery means, said heating means, said positioning means, and said atmospheric pressure control means; and

a power distribution means electrically connected to said delivery mean, said heating means, said positioning means, said atmospheric control means, and said command, control, and communications means and for distributing power to said delivery means, said positioning means, said heating means, said atmospheric pressure control means, and said command, control, and communications means.

58. (Currently Amended) An apparatus for formation of a three dimensional object in interplanetary space by a sequential deposition of a wire feedstock comprising:

a frame;

a positioning subsystem attached to said frame and capable of controlling the position of said object;

a wire feed subsystem attached to said frame and capable of depositing said wire feedstock relative to a target location relative to said position of said object;

an electron beam subsystem capable of directing energy relative to said position of said object and melting said wire feedstock at said target location in a sequential manner and sustaining a molten pool at said target location;

an instrumentation subsystem electronically connected to said electron beam subsystem, positioning subsystem, and wire feed subsystem; and

a power distribution subsystem electrically connected to said electron beam subsystem, positioning subsystem, wire feed subsystem, and said instrumentation subsystem.

59. (Withdrawn) A method for fabricating a three dimensional object from a wire material in a solid freeform fabrication apparatus comprising a sealed container, an electron beam gun, a positioning element, and a wire feed subsystem said method comprising the steps of:

affixing a substrate material to said positioning element;

de-pressurizing said sealed container to a predetermined pressure;

positioning said substrate by moving said positioning subsystem to a predetermined location relative to said substrate and said wire feed subsystem;

heating said substrate with said electron beam gun to create and sustain a molten pool;

depositing said wire material on said substrate and into said molten pool in layers from said wire feed subsystem; and

building successive layers on said substrate by repeating said positioning, heating, and depositing steps.